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GUIDE SPECIFICATION FOR MILITARY CONSTRUCTION

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SECTION 02240

LIME MODIFIED SUBGRADE

1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 25	(1995a) Chemical Analysis of Limestone, Quicklime, and Hydrated Lime
ASTM C 50	(1994) Sampling, Inspection, Packing, and Marking of Lime and Limestone Products
ASTM D 977	(1991) Emulsified Asphalt
ASTM D 1556	(1990) Density of Soil In-Place by the Sand-Cone Method
ASTM D 1557	(1991) Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-Lb. (4.54-kg) Rammer and 18-In. (457-mm) Drop
ASTM D 2167	(1994) Density and Unit Weight of Soil In-Place by the Rubber Balloon Method
ASTM D 2216	(1992) Laboratory Determination of Water (Moisture) Content of Soil, and Rock
ASTM D 2922	(1991) Density of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth)
ASTM D 4643	(1993) Determination of Water (Moisture) Content of Soil by the Microwave Oven Method
ASTM D 3740	(1992)Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM E 329	(1990) Use in the Evaluation of Testing and Inspection Agencies as Used in Construction

1.2 DEFINITIONS

1.2.1 Lime-Modified Subgrade

Lime modified subgrade, as used herein, is a mixture of lime and in-place or select borrow material uniformly blended, wetted, and thoroughly compacted to produce a pavement course which meets all criteria as set forth in the plans and this specification.

1.2.2 Degree of Compaction

Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557, abbreviated hereinafter as percent laboratory maximum density.

1.3 GENERAL

The work specified herein consists of the construction of a lime-modified subgrade course. The work shall be performed in accordance with this specification and shall conform to the lines, grades, notes, and typical sections shown in the plans.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals with a "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL DESCRIPTIONS:

SD-09, Reports

Test Reports; FIO

Results of laboratory tests for quality control purposes shall be submitted to the Contracting Officer and approved prior to using the material.

Copies of field tests results shall be submitted within 24 hours after the tests are performed.

Certified copies of manufacturer's test results indicating compliance of bituminous material with applicable specified requirements shall be submitted to the Contracting Officer not less than 30 days before the material is required in the work.

Sources of all materials shall be selected well in advance of the time that materials will be required in the work. Test results from samples shall be submitted for approval not less than 30 days before material is required for the work.

1.5 STOCKPILING MATERIALS

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NOTE: This paragraph will be deleted when select material is not required or when small quantities do not justify the inclusion of select material.

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Select material, including approved material available from excavation and grading, shall be stockpiled in the manner and at the locations designated. Before stockpiling material, storage sites shall be cleared and sloped to

drain. Materials obtained from different sources shall be stockpiled separately.

1.6 PLANT, EQUIPMENT, MACHINES, AND TOOLS

1.6.1 General Requirements

Plant, equipment, machines, and tools used in the work shall be subject to approval and shall be maintained in satisfactory working condition at all times. Other compacting equipment may be used in lieu of that specified, where it can be demonstrated that the results are equivalent. The equipment shall be adequate and have the capability of producing the results specified. Protective equipment, apparel, and barriers shall be provided to protect the eyes, respiratory system, and the skin of workers exposed to contact with lime dust or slurry.

1.6.2 Steel-Wheeled Rollers

Steel-wheeled rollers shall be the self-propelled type weighing not less than 10 metric tons tons, with a minimum weight of 136 kg 300 pounds per 25 mminch-width of rear wheel. Wheels of the rollers shall be equipped with adjustable scrapers. The use of vibratory rollers is optional.

1.6.3 Pneumatic-Tired Rollers

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NOTE: Types of equipment specified but not required in this type of base course will be deleted, and other items of equipment not listed will be added as appropriate.
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Pneumatic-tired rollers shall have four or more tires, each loaded to a minimum of 9,000 kg 20,000 pounds and inflated to a minimum pressure of 0.62 MPa 90 psi. The loading shall be equally distributed to all wheels, and the tires shall be uniformly inflated. Towing equipment shall also be pneumatic-tired.

1.6.4 Mechanical Spreader

Mechanical spreader shall be self-propelled or attached to a propelling unit capable of moving the spreader and material truck. The device shall be steerable and shall have variable speeds forward and reverse. The spreader and propelling unit shall be carried on tracks, rubber tires, or drum-type steel rollers that will not disturb the underlying material. The spreader shall contain a hopper, an adjustable screed, and outboard bumper rolls and be designed to have a uniform, steady flow of material from the hopper. The spreader shall be capable of laying material without segregation across the full width of the lane to a uniform thickness and to a uniform loose density so that when compacted, the layer or layers shall conform to thickness and grade requirements indicated. The Contracting Officer may require a demonstration of the spreader prior to approving use in performance of the work.

1.6.5 Sprinkling Equipment

Sprinkling equipment shall consist of tank trucks, pressure distributors, or other approved equipment designed to apply controlled quantities of water uniformly over variable widths of surface.

1.6.6 Tampers

Tampers shall be of an approved mechanical type, operated by either pneumatic pressure or internal combustion, and shall have sufficient weight and striking power to produce the compaction required.

1.6.7 Straightedge

The Contractor shall furnish and maintain at the site, in good condition, one 3.05 m 10-foot straightedge for each bituminous paver, for use in the testing of the finished surface. Straightedge shall be made available for Government use. Straightedges shall be constructed of aluminum or other lightweight metal and shall have blades of box or box-girder cross section with flat bottom reinforced to insure rigidity and accuracy. Straightedges shall have handles to facilitate movement on pavement.

1.7 RATES OF MATERIALS APPLICATIONS:

The rate of application of lime for the soil-lime mixture shall be at least 4 percent by dry weight of the nontreated soil. Bituminous material for curing shall be uniformly applied at the rate of 0.45 to 1.8 L per square meter 0.1 to 0.4 gallon per square yard. The exact bituminous material quantities, which may be varied to suit field conditions, will be determined by the Contracting Officer.

1.8 WEATHER LIMITATIONS:

Lime shall not be applied when the atmospheric temperature is less than 4 degrees C 40 degrees F. No lime shall be applied to soils that are frozen or contain frost. If the temperature falls below 2 degrees C 35 degrees F, completed lime-treated areas shall be protected against any detrimental effects of freezing.

2 PRODUCTS

2.1 MATERIALS:

2.1.1 Lime

Lime shall be a standard brand of hydrated lime and shall be of such gradation that 99-1/2 percent passes a 0.850 mm No. 20 sieve and a minimum of 85 percent passes a 0.150 mm No. 100 sieve. Combined calcium oxide and magnesium oxide shall be not less than 70 percent.

2.1.2 Bituminous Material

Material shall be emulsified asphalt ASTM D 977, Type RS-1 or RS-2.

2.1.3 Material to be Modified:

Material shall be free of deleterious substances such as sticks, debris, organic matter, and stones greater than 75 mm 3 inches in any dimension.

2.1.4 Water

Water shall be clean, fresh, and free from injurious amounts oil, acid, or other deleterious materious.

3 EXECUTION

3.1 CONSTRUCTION

3.1.1 Preparation

All roads and pavement areas to be lime modified shall be prepared to approximate subgrade elevations in accordance with Section [02225 EARTHWORK FOR ROADWAYS, RAILROADS, AND AIRFIELDS] [02200 EARTHWORK]. Adequate drainage shall be provided during the entire construction period to prevent water from collecting or standing on the area or on pulverized, mixed, or partially mixed material. Line and grade stakes shall be provided as necessary for control. The area shall be cleaned of debris. The area shall be capable of the compaction specified for the soil-lime mixture. Debris and removed unsatisfactory in-place material shall be disposed of as specified. The entire area shall be graded to approximately conform to the lines, grades, and cross sections shown. Soft or yielding subgrade areas shall be made stable before construction is begun.

3.1.2 Scarifying and Pulverizing of Soil

Prior to application of lime, the in place soil shall be scarified and pulverized as necessary with no stones or lumps larger than 63 mm 2-1/2 inches in any dimension to a sufficient width and depth to obtain a uniform mixture of soil, lime, and water and to form a compacted subgrade conforming to the cross section indicated. Scarification shall be carefully controlled so that the layer beneath the layer to be treated is not disturbed.

3.1.3 Application of Lime

Pulverized material shall be shaped to approximately the cross section indicated. Lime shall be applied at the specified rate. Equipment used for spreading lime shall be approved type which will distribute the lime at controlled uniform rates. Lime shall be applied in a slurry. Distributors shall be used in applying slurry. If lime is spread by hand, the bags shall be spotted so that when the bags are opened the lime will be dumped and spread uniformly on the area being processed. No equipment except that used in spreading and mixing shall pass over the freshly applied lime.

3.1.4 Initial Mixing

Immediately after the lime has been distributed, the lime and soil shall be mixed. Initial mixing shall be sufficient to alleviate any dusting or wetting of the lime that might occur in the event of wind or rainstorms. This may be accomplished several days in advance of the final water application and mixing.

3.1.5 Water Application and Final Mixing

Moisture content of the mixture shall be determined prior to final mixing and water shall be added as required. Moisture in the mixture following final mixing shall be between optimum and 3 percent above optimum. Water shall be incrementally incorporated and simultaneously intermixed into the soil. After the last portion of water has been added, mixing shall be continued until the water is uniformly distributed throughout the full depth of the mixture. Particular care shall be taken to ensure satisfactory moisture distribution along the edges of the section.

3.1.6 Compaction

Before compaction operations are started and as a continuation of the mixing operation, the mixture shall be thoroughly loosened and pulverized to the full depth. The soil lime mixture shall be reduced in size to meet the following requirements when tested dry by laboratory sieves: Min. passing 38 mm 1-1/2 inch - 100 percent; Min. passing 6.3 mm No. 4 sieve-60 percent. Compaction shall be started immediately after mixing is completed. During final compaction, the surface shall be moistened, if necessary, and shaped to the required lines, grades, and cross section. Density of compacted mixture shall be at least 95 percent of maximum density. Rolling shall begin at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Alternate trips of the roller shall be slightly different lengths. The speed of the roller at all times shall be such that displacement of the mixture does not occur. Areas inaccessible to the rollers shall be compacted with mechanical tampers, and shall be shaped and finished by hand methods. Final compacted thickness of the subgrade shall be as indicated. No layer shall be in excess of 200 mm 8 inches or less than 75 mm 3 inches in compacted thickness.

3.1.7 Edges

Approved material shall be placed along the edges of the course in such quantity as will compact to the thickness of the course being constructed, allowing at least a 300 mm 1-foot width of the shoulder to be rolled and compacted simultaneously with the rolling and compacting of the subgrade.

3.1.8 Finishing

The surface shall be finished to the grade and cross section shown. The surface shall be of uniform texture. Should the surface for any reason become rough, corrugated, uneven in texture, or traffic-marked prior to completion, such unsatisfactory portions shall be scarified, reworked, relaid, or replaced as directed. Should any portion of the course, when laid, become watersoaked for any reason, that portion shall be removed immediately, and the mix placed in a windrow and aerated until a moisture content within the limits specified is obtained, and then spread, shaped, and rolled as specified above.

3.1.9 Thickness Control

Completed thickness of the subgrade course shall be not more than 13 mm 1/2 inch below the thickness indicated. Where more than 13 mm 1/2 inch deficient, such areas shall be corrected by scarifying, adding proper mixture, reblading, and recompacting as directed. The average of all thickness measurements taken for the job shall be within 6 mm 1/4 inch of the thickness indicated.

3.1.10 Construction Joints

At the end of each phase of construction, a straight transverse construction joint shall be formed by cutting back into the completed work to form a true vertical face free of loose or shattered material. Material along construction joints not properly compacted shall be removed and replaced with soil-lime mixture that is mixed, moistened, and compacted as specified.

3.2 CURING

Immediately after finishing the surface shall be protected against rapid drying by bituminous material curing. Emulsified asphalt bituminous material shall be uniformly applied at a rate of 0.45 to 1.8 L per square meter 0.1 to 0.4 gallons per square yard by means of a bituminous distributor at a temperature within the following ranges:

RS-1	25-55C 75-130F
RS-2	45-70C 110-160F

Areas inaccessible to or missed by the distributor shall be properly treated using the manually operated hose attachment. At the time the bituminous material is applied, the surface of the area shall be free of loose or foreign matter. When necessary, the area shall be sprinkled immediately before the bituminous material is applied.

3.3 PROTECTION

Completed portions of the subgrade may be opened immediately to light traffic provided the curing is not impaired. After the curing period, completed areas may be opened to all traffic, provided the course has hardened sufficiently to prevent marring or distorting of the surface by equipment or traffic. Heavy equipment shall not be permitted on the area during the curing period. Lime and water may be hauled over the completed area with pneumatic-tired equipment if approved. Finished portions of the surface that are traveled on by equipment used in constructing an adjoining section shall be protected in a manner to prevent equipment from marring or damaging completed work.

3.4 MAINTENANCE

The subgrade shall be maintained in a satisfactory condition until the completed work is accepted. Maintenance shall include immediate repairs of any defects and shall be repeated as often as necessary to keep the area intact. Defects shall be corrected as specified herein.

3.5 DISPOSAL OF UNSATISFACTORY MATERIALS

Removed in-place materials that are unsuitable for stabilization, material that is removed for the required correction of defective areas, waste material, and debris shall be disposed of as directed.

3.6 SAMPLING AND TESTING

3.6.1 General Requirements

Sampling and testing shall be the Contractor's responsibility and shall be performed by an approved commercial testing laboratory or by facilities furnished by the Contractor. Approval of testing facilities shall be based on compliance with ASTM D 3740 and ASTM E 329 and no work requiring testing shall be permitted until the facilities have been inspected and approved. The first inspection shall be at the expense of the Government. Cost incurred for any subsequent inspection required because of failure of the facilities to pass the first inspection will be charged to the Contractor. Three copies of the test results shall be furnished the Contracting Officer within 24 hours of conclusion of the test.

3.6.2 Samples

Samples of lime shall be taken in accordance with ASTM C 50.

3.6.3 Testing

Field in-place density shall be determined in accordance with ASTM D 1556, ASTM D 2167, or ASTM D 2922. If ASTM D 2922 is used, in place densities shall be checked by ASTM D 1556 at a frequency of one sand cone test for each 8 nuclear tests and not less than one sand cone test per lift.

The sand cone test shall be performed adjacent to the area where a nuclear density test was run to insure a proper correlation is established. Material from the sand cone location shall be tested to determine the laboratory maximum dry density as specified hereinafter. Moisture contents shall be determined in accordance with ASTM D 4643 or ASTM D 2216. If ASTM D 4643 is used, moisture contents shall be checked by ASTM D 2216 once per each ten microwave tests. At least one field density test and one moisture content test shall be performed for each 836 square meters 1000 square yards of each layer of modified subgrade.

3.6.4 Thickness

Completed thicknesses of the modified course shall be within 13 mm 1/2 inch of the thickness indicated. Where the measured thickness of the modified course is more than 13 mm 1/2 inch deficient, such areas shall be corrected by scarifying, adding mixture of proper gradation, reblading, and recompacting as directed. Where the measured thickness of the modified course is more than 13 mm 1/2 inch thicker than indicated, it shall be considered as conforming to the specified thickness requirement. Average job thickness shall be the average of all thickness measurements taken for the job, but shall be within 6 mm 1/4 inch of the thickness indicated. Thickness of the modified course shall be measured at intervals in such a manner as to ensure one measurement for each 418 square meters 500 square yards of modified course. Measurements shall be made in 75 mm 3-inch diameter test holes penetrating the modified course.

3.6.5 Smoothness

The surface of the modified layer shall show no deviations in excess of 10 mm 3/8 inch when tested with a 3.05 m 10-foot straightedge. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting, as directed. Measurements for deviation from grade and cross section shown shall be taken in successive positions parallel to the road centerline with a 3.05 m 10-foot straightedge. Measurements shall also be taken perpendicular to the road centerline at 15 m 50-foot intervals.

3.6.6 Laboratory Density

The laboratory maximum dry density and optimum moisture content of the lime-soil mixture shall be determined from samples obtained at a selected sand cone test location. A minimum of one laboratory maximum density test shall be run each placement day or fraction thereof. Additional laboratory density tests shall be run each material change. Tests shall be conducted in accordance with ASTM D 1557.

3.6.7 Chemical Analysis

Lime shall be tested for the specified chemical requirements in accordance with ASTM C 25.